Dynamic Topology Control using Cooperative MAC

Saba Parveen, Rajendra Tiwari

Computer Science and Engineering, Bansal Institute of Science and Technology, Bhopal, India

Abstract— An adhoc wireless network consists of a collection of geographically distributed nodes that communicate with one other over a wireless medium. An adhoc wireless network are differ from the cellular network in a way that there in no fixed wired infrastructure. In adhoc network communication capabilities depends on the battery power of the network nodes. In this paper, we address the topology control with cooperative communication problem in adhoc wireless networks. Cooperative communication allows combining partial message to decode a complete message with less transmission power. Cooperative communication reduce the transmission power and extends the transmission coverage. However there are several research on topology control with cc only focuses on maintaining network connectivity, minimizing the transmission power of each node whereas recently energy efficiency of paths in constructed topology is introduced. In this only energy efficiency of path in constructed topology for static cooperative adhoc network. When unexpected changes in the network such as link and node failures are occur in cooperative communication in adhoc wireless network then this may causes inefficient routes and hurts the overall performance in cooperative adhoc network. Therefore in this paper we address this problem by handling the energy efficiency.

Keywords—Cooperative communication, topolpgy control, energy efficiency.

I. INTRODUCTION

Adhoc wireless network consists of wireless nodes that communicate with each other via radio transmitters in the absence of fixed infrastructure. Wireless nodes are limited operational time as they have powered by battery. Adhoc wireless network are different from cellular network in that there is fixed infrastructure. Adhoc wireless network have distributed routing whereas cellular network have centralized routing. Main aim of routing is to find paths with minimum overhead and also quick reconfiguration of broken paths. Transmission range of node vary by varying the power with which it transmit a message. A range assignment for a network is a power setting of each node, and the cost of range assignment is either average power setting or the maximum power setting in that assignment. The goal in this setting is to minimize power consumption and maintaining network properties. A classical example of adhoc wireless network in the field of war. Adhoc wireless network can be very useful in establishing communication among a group of soldiers for tactical operation. For setting up fixed infrastructure in the field of war is not impossible in such environments, adhoc wireless network provide the required communication quickly. Another example in this area is can be coordination of military object moving at high speed such as fleets of airplanes or warships. Such type of application required secure and reliable communication. Adhoc wireless network are very useful in emergency operation such as search and rescue, crowd control and commando operation. The major factors that favor adhoc wireless network for such tasks are self configuration of the system with minimal overhead, independent of fixed or centralized infrastructure.

Another domain in which the adhoc wireless network find application is collaborative computing.

II. MAC LAYER

In order to provide the dynamicity, we take the advantage of medium access control layer. The MAC sublayer forms the lower half of the data link layer. It directly interfaces with the physical layer. The MAC sublayer provides addressing and channel access control mechanisms that make it possible for several terminals or network nodes to communicate within a multiple access network that incorporates a shared medium. It also provides services such as addressing , framing and medium access control. The MAC sublayer acts an interface between the logical link control(LLC) sublayer and the network’s physical layer. It is relevant to network (such as LANs) where a single broadcast transmission channel needs to be shared by multiple competing machines. It emulates a full duplex logical communication channel in multi-point network. This channel provides unicast, multicast or broadcast communication service.

Functions performed in the MAC sublayer are received/transmit normal frames, half-duplex retransmission and backoff function, append/check FCS, interframe gap enforcement, discard malformed frames, append/remove preamble SFD and padding, half-duplex compatibility, append/remove MAC address.

Some of the important medium access control mechanisms are ALOHA, CSMA, CSMA/CD. Aloha is one of the mechanisms of MAC. In this a radio transmitter is attached to each terminal. A user(terminal) transmit whenever data is ready for transmission. In slotted ALOHA channel is divided into time into discrete interval/slots. The length of each slot is equal to frame length used. The slot boundaries are the same for all users, that is time is synchronized. Here a node does not transmit as soon as a packet becomes ready for transmission. Instead it waits till the beginning of the next slot interval and then transmit. The vulnerable period in the slotted ALOHA scheme is equal to the slot interval which is equal to the frame length. This is half of that pure ALOHA scheme.

Another MAC mechanism is CSMA in which node before transmitting the packet, first they listen carrier on the channel and then make decision on them. The primary responsibility of a medium access control (MAC) protocol in adhoc wireless network is the distributed arbitration for the shared channel for transmission of packets.

Addressing mechanism of MAC sublayer are such that each device having unique mac address .The local network addresses used in ieee network and fddi network are known as mac addresses. A MAC address is unique serial number. Once a Mac address has been assigned to a particular network interface that device is uniquely identified among all the others network device in the world. This assured that each devices in the network having unique mac address. Data packet is to be delivered to the destination within the same network ie nodes are interconnected by some combination of repeater, hubs, switches but not by network routers are possible.

The channel access control mechanism provided by the MAC layer are known as a multiple access protocol. Through this it is possible for several nodes connect to the same physical medium to share it. Examples of shared medium are bus network, ring networks, hubs network, wireless network and half-duplex point-to-point links. When packet mode contention based channel access method is used, or reserve resource to established a logical channel if a circuit switched or channelization based channel method is used the multiple access protocol may detect or avoid data packet collision. The most used multiple access channel is CSMA/CD protocol. Common multiple access protocols are CSMA/CD, token ring, token bus. Examples of common multiple access protocol that may be used in radio wireless network are CSMA/CD, slotted aloha, dynamic TDMA, reservation ALOHA, mobile slotted ALOHA, CDMA, OFDMA.

III. COOPERATIVE COMMUNICATION

Cooperative communication is recently introduced that allows combining partial messages to decode a complete message with less transmission power. It allow single antenna device to take the advantage of the multiple input multiple output system. Cooperative communication and networking is one of the emerging technologies that promises significantly higher reliability and spectral efficiency in wireless networks. Unlike conventional point-to-point communications, cooperative communication is a new form of diversity that allows users or nodes to share resources to create collaboration via distributed transmission and processing of messages. This cooperative diversity concept is similar to the multiple-input multiple-output (MIMO) system but is applied in a networked setting. As a result, it is often called a distributed MIMO or network MIMO. It represents a paradigm shift from a network of conventional point-to-point links to network cooperation. The cooperative communication allow nodes that have received the transmitted signal to cooperatively help relaying data for other nodes. The cooperative communication techniques can also be used in topology control to reduce the transmission energy consumption or to improve the network connectivity.

The network resource management and optimization problem in wireless network. A wireless mash network is a communication network consisting of radio nodes connected in a mesh topology. Different from a cellular network, where each radio node communicates to other nodes through a base station, nodes in a WMN can communicate with each other directly or through one or more intermediate nodes. A WMN is a special type of mobile adhoc network. It often has a more “planned” network configuration and relatively “static” topology instead of an “ad hoc” network formulation and highly “dynamic” topology, typical of most mobile ad hoc networks. A WMN has a hierarchical architecture with regular nodes as the clients and special nodes as the mesh routers and gateways. Resource allocation in such networks needs to take this particular network architecture into consideration.

While connectivity is arguably the most critical performance metric for a wireless network to ensure end-to-end delivery, one cannot assume that any two nodes can always keep connected all the time. Channel fading, interference, and mobility, etc., may cause link disruptions and disconnection. This is especially true for the emerging type of wireless networks such as ad hoc networks, where highly dynamic changes in network topology and link connectivity occur frequently and unexpectedly. Among various approaches to ensure connectivity in wireless networks, cooperative communication shows great potential. Various cooperative communication and networking techniques, as presented in many publications in recent years, have shown the concrete advantages and potential of node cooperation and sharing resources. However, there remain challenges to achieve the full potentials of cooperation. Besides the technical challenges of finding practical solutions to implement cooperation, there are issues in other disciplinary areas such as the user’s social behavior and willingness to join a cooperative network. It is of great interest to investigate the connectivity in cooperative networks with selfish nodes, treating the cooperative diversity and node's selfish behavior jointly.

The above rationale motivates our research on this specific aspect for cooperative communication networks. Our objective is to quantify the connectivity for cooperative ad hoc networks with user selfishness defined as a p-selfishness probability model, as a first step. We derive an upper bound of critical node densities for such systems to percolate.

In most work on cooperative communication, it is assumed that nodes in a collaborative cluster are expected to cooperatively transmit at all times, no matter whether the transmitted messages are their own or belong to other nodes. This assumption may not be true, especially when the nodes have intelligence or knowledge of the transmitted information, or self-awareness. For example, nodes may become selfish and may not be willing to relay other nodes' traffic if it means consuming their own resources (e.g., battery and time). Therefore nodes may not cooperatively transmit at some time. Our objective is to analyze the connectivity for a cooperative network with selfish nodes. More specifically, we would like to obtain the critical node density needed for percolation to occur in a cooperative network.

IV. ROUTING TECHNIQUES

Routing protocol in wireless is depends on the application and network architecture. The routing techniques are classified into three categories based on the underlying structure flit, hierarchical and location-based routing. Furthermore, these protocol is classified into multipath-based, query-based, negotiation-based, QoS-based and coherent-based depending on the protocol operation. In wireless network nodes often operate unattended in a collaborative manner to perform some tasks. In many application nodes are deployed in harsh environments such as battlefield where the nodes are susceptible to damage. In addition nodes may fail due to energy breakdown and depletion. The failure of the nodes may leave some area uncovered and degrade the reproduction of the collected data. However the most serious consequence is when the network are partitioned into disjoint segments. Due to these the network connectivity is losing and reflect the negative effect on the applications since it prevents data exchanges and hinders the coordination among some nodes of the network. Therefore restoring the network connectivity is one of the crucial work. This paper focuses on topology control in unexpected change in the cooperative adhoc network such as link, nodes failure.

Topology control techniques are used to reduced the energy consumption which is essential to extend the radio interference. The goal of this technique is to control the topology of the cooperative adhoc network with the purpose of maintaining the network property.

V. CONCLUSION

In this paper, we introduced a new topology control problem: energy-efficient topology control problem with cooperative communication ,when unexpected changes in the network such as link and node failures occurs , which aims to keep the energy efficient paths in the constructed topology. Energy efficiency impacts energy consumption in wireless adhoc network.

VI. REFERENCES

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